

CLAIMS:

1. A system for treating cardiac arrhythmia, the system comprising:
 - a sensing lead configured to sense electrical signals attendant to the depolarization and repolarization of a heart;
 - a processor configured to receive the electrical signals, to detect cardiac arrhythmia from the electrical signals, to discriminate between an atrial arrhythmia and a ventricular arrhythmia as a function of the electrical signals, and to generate an arrhythmia signal as a function of the type of arrhythmia discriminated from the electrical signals; and
 - 10 a drug delivery system configured to receive the arrhythmia signal, the drug delivery system comprising:
 - a first drug pump containing a first drug;
 - a second drug pump containing a second drug;
 - a first infusion apparatus coupled to the first drug pump; and
 - 15 a second infusion apparatus coupled to the second drug pump,
 - wherein the drug delivery system is configured to activate the first drug pump to dispense the first drug via the first infusion apparatus when the arrhythmia signal is indicative of atrial arrhythmia, and
 - 20 wherein the drug delivery system is configured to activate the second drug pump to dispense the second drug via the second infusion apparatus when the arrhythmia signal is indicative of ventricular arrhythmia.
2. The system of claim 1, further comprising a pacing system coupled to the processor, the pacing system including a pacing lead configured to provide pacing pulses to cardiac tissue.
- 25 3. The system of claim 1, wherein the system is implantable in a human body.

4. The system of claim 1, wherein the sensing lead is a first sensing lead, the system further comprising a second sensing lead configured to sense electrical signals attendant to the depolarization and repolarization of the heart, wherein one of the sensing leads is located in an atrium of the heart and the other of the sensing leads is located in a ventricle

5 of the heart.

5. The system of claim 1, further comprising a controller, the controller configured to receive the arrhythmia signal, to generate a first control signal to activate the first drug pump when the arrhythmia signal is indicative of atrial arrhythmia, and to generate a second

10 control signal to activate the second drug pump when the arrhythmia signal is indicative of ventricular arrhythmia.

6. The system of claim 5, further comprising memory, the controller interacting with the memory to access treatment instructions and parameters.

15 7. The system of claim 5, further comprising an input/output device coupled to the controller.

8. The system of claim 1, the drug delivery system further comprising:

20 a third drug pump containing a third drug; and

a third infusion apparatus coupled to the third drug pump;

wherein the drug delivery system is configured to activate the third drug pump as a function of the arrhythmia signal.

25 9. The system of claim 1, wherein the first drug is selected from the group consisting of digitalis and beta blockers.

Title: DRUG DELIVERY FOR TREATMENT OF CARDIAC ARRHYTHMIA
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10. The system of claim 1, wherein the second drug is selected from the group consisting of lidocaine and amiodarone.

11. A method of treating arrhythmia in a patient,

5 wherein a drug delivery system has been implanted in the patient, the drug delivery system comprising a first drug pump containing a first drug and a second drug pump containing a second drug, the method comprising:

receiving an arrhythmia signal indicative of one of atrial arrhythmia or ventricular arrhythmia;

10 activating the first drug pump to dispense the first drug when the arrhythmia signal is indicative of atrial arrhythmia, and

activating the second drug pump to dispense the second drug when the arrhythmia signal is indicative of ventricular arrhythmia.

15 12. The method of claim 11, further comprising:

monitoring the heart rhythm of the patient; and

generating an arrhythmia signal when the heart rhythm meets defined arrhythmia criteria.

20 13. The method of claim 11, further comprising:

selecting a first drug dosage;

activating the first drug pump to dispense the first drug dosage;

selecting a second drug dosage; and

activating the second drug pump to dispense the second drug dosage.

25 14. The method of claim 13, wherein a dosage comprises one of a drip dosage or a bolus dosage.

15. The method of claim 11, wherein the arrhythmia signal is further indicative of acute ventricular arrhythmia, the method further comprising:

activating the second drug pump to dispense a bolus of the second drug; and applying a defibrillating pulse to the patient's heart.

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16. The method of claim 15, wherein the defibrillating pulse is applied after the bolus is dispensed.

17. A system comprising:

10 a processor configured to receive the electrical signals from a heart and to generate an arrhythmia signal as a function of the type of electrical signals, the arrhythmia signal indicative of one of atrial arrhythmia or ventricular arrhythmia; and

15 a drug delivery system configured to receive the arrhythmia signal, the drug delivery system comprising a drug pump and an infusion apparatus coupled to the drug pump,

15 wherein the drug delivery system is configured to activate the drug pump to dispense the drug via the infusion apparatus when the arrhythmia signal is indicative of one of atrial arrhythmia and ventricular arrhythmia.

18. The system of claim 17, wherein the drug delivery system is configured to stand idle 20 when the arrhythmia signal is indicative of the other of atrial arrhythmia and ventricular arrhythmia.

19. The system of claim 18, wherein the system is implantable in a human body.

25 20. The system of claim 17, further comprising a pacing system coupled to the processor.

21. The system of claim 17, further comprising a sensing lead configured to sense electrical signals attendant to the depolarization and repolarization of the heart.

22. The system of claim 17, further comprising a controller, the controller configured to 5 receive the arrhythmia signal, to generate a control signal to activate the drug pump when the arrhythmia signal is indicative of one of atrial arrhythmia and ventricular arrhythmia.

23. A method for treatment of arrhythmia in a patient comprising:

implanting in the patient a sensing lead configured to sense electrical signals

10 attendant to the depolarization and repolarization of the patient's heart;

implanting in the patient a processor configured to receive the electrical signals, to detect cardiac arrhythmia from the electrical signals and to discriminate between an atrial arrhythmia and a ventricular arrhythmia as a function of the electrical signals;

implanting in the patient a drug delivery system comprising a first drug pump

15 containing a first drug and a second drug pump containing a second drug;

monitoring the patient's heart rhythm using the sensing lead and the processor;

upon detection of arrhythmia, determining the type of the arrhythmia using the processor;

responsive to atrial arrhythmia, activating the first drug pump to dispense the first

20 drug to the patient; and

responsive to ventricular arrhythmia, activating the second drug pump to dispense the second drug to the patient.

24. The method of claim 23, further comprising implanting a pacing system, the pacing 25 system including a pacing lead configured to provide pacing pulses for causing depolarization of cardiac tissue.

25. The method of claim 23, further comprising:

implanting in the patient a device configured to apply a defibrillating pulse to the patient's heart;

activating the first drug pump to dispense a bolus of the first drug; and
applying a defibrillating pulse to the patient's heart.

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26. The method of claim 23, further comprising:

implanting in the patient a device configured to apply a defibrillating pulse to the patient's heart;

activating the second drug pump to dispense a bolus of the second drug; and
10 applying a defibrillating pulse to the patient's heart.

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27. The method of claim 23, further comprising:

implanting in the patient a first infusion apparatus coupled to the first drug pump and a first infusion site; and

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implanting in the patient a second infusion apparatus coupled to the second drug pump and a second infusion site.

28. The method of claim 27, wherein an infusion site is one of subclavian vein, superior vena cava and fatty tissue.

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29. The method of claim 23, further comprising

implanting in the patient a controller configured to activate the first drug pump in response to atrial arrhythmia and to activate the second drug pump in response to ventricular arrhythmia.

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30. The method of claim 29, further comprising programming the controller with atrial arrhythmia criteria.

31. The method of claim 29, further comprising programming the controller with ventricular arrhythmia criteria.

32. The method of claim 29, further comprising programming the controller with 5 criteria for delivery of the first and second drugs, wherein criteria for delivery includes minimum dosage, maximum dosage and frequency of administration.

33. The method of claim 23, wherein the first drug pump includes a first reservoir containing the first drug, wherein the second drug pump includes a second reservoir 10 containing the second drug, the method further comprising:

refilling the first reservoir with the first drug; and
refilling the second reservoir with the second drug.

34. The method of claim 33, wherein refilling a reservoir comprises refilling a reservoir 15 using a needle and syringe.

35. A system for treating cardiac arrhythmia comprising:
a processor configured to detect cardiac arrhythmia, to discriminate between an 20 atrial arrhythmia and a ventricular arrhythmia, and to generate an arrhythmia signal as a function of the type of arrhythmia;

a drug delivery system comprising a first drug pump containing a first drug, a second drug pump containing a second drug, a first infusion apparatus coupled to the first drug pump and a second infusion apparatus coupled to the second drug pump; and

25 a controller configured to receive the arrhythmia signal, to generate a first control signal to activate the first drug pump to dispense the first drug via the first infusion apparatus when the arrhythmia signal is indicative of atrial arrhythmia, and to generate a second control signal when the arrhythmia signal is indicative of ventricular arrhythmia, and to generate a second control signal to activate the second drug pump to dispense the second

drug via the second infusion apparatus when the arrhythmia signal is indicative of ventricular arrhythmia.

36. The system of claim 35, further comprising a sensing lead coupled to the processor,

5 the sensing lead configured to sense electrical signals attendant to the depolarization and repolarization of a patient's heart.

37. The system of claim 35, further comprising a pacing system coupled to the processor, the pacing system including a pacing lead configured to provide pacing pulses

10 for causing depolarization of cardiac tissue.

38. The system of claim 37, further comprising a device coupled to the pacing system configured to apply a defibrillating pulse to the cardiac tissue.

15 39. The system of claim 35, wherein the processor, drug delivery system and controller are implantable in a human body.

40. A system for treating cardiac arrhythmia comprising:

means for sensing electrical signals attendant to the depolarization and

20 repolarization of a heart;

means for detecting an arrhythmia from the electrical signals;

means for discriminating between an atrial arrhythmia and a ventricular arrhythmia;

and

means for drug delivery comprising a first drug pump means and a second drug

25 pump means,

wherein the first drug pump means contains a first drug and the second drug pump means contains a second drug,

wherein the first drug pump means dispenses the first drug when the arrhythmia is atrial arrhythmia, and

wherein the second drug pump means dispenses the second drug when the arrhythmia is ventricular arrhythmia.

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41. The system of claim 40, further comprising a pacing system means configured to provide pacing pulses to cardiac tissue in response to the electrical signals.

42. The system of claim 40, wherein the system is implantable in a human body.

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43. The system of claim 40, further comprising controlling means configured to activate the first drug pump when the arrhythmia is atrial arrhythmia, and to activate the second drug pump when the arrhythmia is ventricular arrhythmia.

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